PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to Mounting Units

We, METALASTIK LIMITED, a British Company, of Evington Valley Road, Leicester, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention concerns improvements relating to mounting units of the type comprising a base and a support member presenting in combination at least two pairs of confronting surfaces and a rubber block or like pad between each such pair of surfaces, the pads having their compression axes, normal to the respective pairs of surfaces, arranged in V-formation in relation to one another symmetrically about a static loading axis and carrying the support member on the base member. Such mounting units, hereinafter referred to as mounting units of the type described are used to support machinery, engines, generators, instruments or the like, the rubber pads being in combined shear and compression under the superimposed vertical load of the machinery and providing a resilient, anti-vibration support for the machinery.

In the simplest case such mounting units are known to comprise two rubber pads arranged with their compression axes in V-formation. Alternatively however there may be four rubber pads, one between each of four pairs of said confronting surfaces following the form of a square pyramid.

Hitherto, mountings of the type described have utilised rubber pads having the same stiffness in shear and compression, the mountings providing a reaction in the direction opposite to that of the vertically applied load on the support member when set horizontally with the rubber pads or blocks all equally inclined to the direction of the applied load so that under the applied load the pads are all equally stressed in combined shear and compression.

Because of the vertical reaction in these circumstances, a mounting installation employing a plurality of horizontally set mountings of the type described, arranged in a horizontal plane to support say an engine or other piece of machinery on top of the mountings, cannot have its mountings focused at or near the centre of gravity of the supported mass.

On the other hand it is accepted that in certain installations in which a mass is supported on rubber mountings there are advantages in focusing the rubber mountings at or near the centre of gravity of the supported mass.

To enable this to be achieved with mountings of the type described, whilst maintaining the mountings in a horizontal disposition, the present invention provides a mounting unit of the type described wherein at least two of the rubber pads are constructed to exhibit compressive stiffnesses one selectively greater than the other and the arrangement of the pads is such as to impart to the unit a direction of maximum stiffness inclined to said static loading axis.

That is, the mounting as a whole is provided with a direction of maximum stiffness in a vertical plane which direction is inclined to the direction of loading i.e. to the vertical, this with the mounting set horizontal as is required.

In said vertical plane of maximum stiffness, the minimum stiffness is in a direction at right right angles to the direction of maximum stiffness.

For change in loading, although not for static i.e. normal mean loading as hereinafter explained, the mounting may therefore be compared with a known form of mounting employing a single rubber block or pad set

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at an angle to the vertical, and two such mountings spaced apart in a horizontal plane with a pair of rubber pad mountings spaced apart and arranged in a vee. As is well known, a pair of rubber pad mountings arranged in this fashion are focused on a common point, and it follows therefore that a pair of mountings according to the present invention, arranged in the manner aforesaid, are likewise focused on a common point.

The invention will now be further described and explained, merely by way of example, with reference to the accompanying drawings.

In the accompanying drawings:—

Fig. 1 illustrates an installation employing mounting units as shown in Fig. 2;

Fig. 2 is a somewhat diagrammatic cross-section of a mounting unit of the type described but not in accordance with the present invention;

Fig. 3 is a somewhat diagrammatic cross-section of one mounting unit according to the present invention;

Fig. 4 is a diagram of an installation employing mounting units as shown in Fig. 3, and

Fig. 5 is a plan view, with part removed, of another mounting unit according to the present invention.

Referring to Fig. 1, the installation there shown comprises a piece of machinery 10 which is supported upon mounting units 11. The machinery 10 is rectangular and a mounting 11 is provided at each corner of the machinery.

Each mounting 11 comprises (Fig. 2) a base member 12, which rests on a foundation 13, a support member 14 and rubber blocks or like pads 15. The members 12, 14 have inverted V-surfaces 16, 17 respectively which confront each other in pairs. Between each pair of confronting surfaces there is a block 15.

The vertical load L due to the machinery 10 subjects block 15 to combined shear S and compression C.

The mountings 11 are in a horizontal plane (see Fig. 1) not greatly below the centre of gravity x of the machinery 10. The blocks 15 have the same stiffness in shear and compression and the compression axes are at 45° to the vertical, in V-formation and normal to the respective pairs of surfaces.

The direction of the resultant force of each mounting in supporting the load of the machinery 10, is vertical i.e. each mounting provides a reaction in the direction opposite to that of the vertically applied load which stresses the blocks 15 of each mounting equally in combined shear and compression. Such a mounting also reacts symmetrically for change in loading due to forces set up in the machinery when operating.

Referring now to Fig. 3, which diagrammatically illustrates a mounting according to this invention, the parts are as described above with regard to Fig. 2 wherein, however, one of the blocks 115 has a compressive stiffness (Cs1) which is greater than that (Cs2) of the block 215. The shear stiffnesses (Ss1) and (Ss2) are about the same for both blocks 115 and 215. It is assumed that the included angle of the V is 90° so that the total stiffness in the direction P is the sum of Cs1 and Ss2 while the total stiffness in the direction Q is the sum of Cs2 and Ss1.

For instance, it may be arranged that:—

Cs1 equals 20 units
Cs2 equals 8 units
Ss1 equals 1 unit
Ss2 equals 1.5 units, so that the total stiffness in the direction P is 21.5 units and in direction Q is 9 units.

Thus, the ratio of the stiffness in directions P and Q is 21.5/9=2.39, and this is the ratio of the maximum and minimum stiffnesses of the mounting.

The mounting is therefore comparable as mentioned above to a single rubber pad or block mounting, like the block 115, set at an angle of 45° to the vertical and having a compression stiffness 2.39 times its shear stiffness.

Consider now a pair of units as shown in Fig. 3 spaced apart and arranged in a common horizontal plane as shown in Fig. 4.

It should be explained that the blocks of the mountings of the invention would generally be arranged so that in the static i.e. normal laden condition in an installation the reaction of each mounting unit is vertical, that is coincident with the normal static loading axis of the unit, as in the case of the known mounting shown in Fig. 2. There is therefore no shear loading component tending to displace the mounting parts, which is often considered to be a disadvantage of the above-mentioned V-arrangement of a pair of spaced single rubber pad mountings.

However, for change of loading from the normal a pair of units of the invention as arranged in Fig. 4 are comparable to such a V-arrangement.

Thus, for change in loading the reaction of each of the mountings (which then coincides with the line of direction of maximum stiffness) is no longer vertical (as in the unit of Fig. 2) but is inclined along a line r. The lines r for the pair of units are arranged to intersect at a point in the vertical plane containing the centre of gravity x.

Applying the usual formula $\tan\beta \tan(\alpha-\beta)=\frac{1}{k}$, for mountings in a vee, to find the correction angle β, and thus the upward inclination from the horizontal to the effective point of suspension o, k being 1.695 in this formula, and β and α being the angles

shown, the upward inclination referred to may be shown to be 15°.

By suitable selection of the stiffness ratio, the point *o* may be made to lie within limits, a specified distance above the horizontal plane *p*. It is preferred that the point *o* is below the centre of gravity *x* of the machine but the point may be at, or slightly above, the centre of gravity in certain circumstances.

The effective point of suspension *o* is the effective point of action of the two mountings in their plane of symmetry c—c through which a force in any direction will produce only linear deflection of the machine carried by the mountings and about which a couple acting on the machine about a direction normal to the plane of symmetry will turn the machine without accompanying linear deflection.

By arranging the effective point *o* below the centre of angular oscillation about a horizontal axis of say an engine mounted on the mounting units, an angular oscillation in the direction *t* for instance, the blocks 115, which are of greater stiffness, will be deformed mainly in shear, and the blocks 215, of lesser stiffness, mainly in compression, and these additional effects might well be used to to reduce the pitching and yawing frequencies of the mounting installation below those of the engine at idling speed whilst still obtaining a satisfactory static deflection in the vertical direction for the mountings of the installation.

The greater stiffness of blocks 115 may be provided by incorporating a metal interleaf 20 to which the parts of the block are bonded. More than one interleaf may be used if required. Any other means may be provided to this end instead of, or additionally to, the interleaf, e.g. by suitable choice of the rubber mix to compose the blocks 115.

To ensure that the mounting units are horizontal in their supports i.e. the support member 14 of each unit does not sag on the side of lesser stiffness, it may be arranged that the blocks of lesser stiffness are precompressed to a greater extent than the other blocks. Thus, the blocks 215 may be thicker than the blocks 115 prior to the assembly of the units, each unit, on assembly, being drawn up against a rebound buffer (not shown) engaged under the member 12, by a bolt or the like engaged between the member 14 and the foundation 13 so that the member 14 becomes horizontal under the precompression loading in the bolt. Such measures may ensure that in the normal laden condition the reaction of each mounting unit is vertical, is discussed above.

The invention finds practical application in mounting units of the type described and having four blocks arranged on a square pyramid, as shown in Fig. 5. In this case a pair of greater compressive stiffness blocks 115 are arranged next to each other (these having interleaves 20) and a pair of lesser compressive stiffness blocks 215 are also next to each other. The stiffnesses in shear and compression of blocks 115 is the same as also is the stiffness in shear and compression of blocks 215.

In this case the adjacent blocks 115 of the same stiffness in shear and compression may be regarded as a single block having resultant maximum and minimum stiffnesses relative to the vertical plane containing the line of inter-section of the faces of the pyramid on which the adjacent blocks are mounted. Same goes for the adjacent blocks 215. The mounting shown in Fig. 5 therefore reduces in effect to a mounting as described with reference to Fig. 3.

A mounting installation employing mounting units according to the present invention may employ four mounting units disposed one at each corner as shown in Fig. 1, the units being focused on a point at or near the centre of gravity *x*. Preferably, as previously explained, the units are focused on a point which lies above the horizontal plane of the units but below the centre of gravity.

Instead of employing four mounting units, the installation could employ only three units, the three units being focused on a point at or near the centre of gravity, the units again being disposed in a horizontal plane one for example at each corner of an equilateral triangle.

In either case, the units would be arranged so that angular oscillations of the machine or other body supported on the units about a substantially horizontal axis would subject the blocks of greater compressive stiffness mainly to shear deformation and the blocks of lesser compressive stiffness mainly to compressive deformation.

The term " rubber " as used in this specification is intended to include rubber-like material.

The mounting unit described with reference to Fig. 5 is constructed and arranged generally as described and claimed in our British Patent Specification No. 741,486 except of course that an adjacent pair of the rubber pads or blocks are of a greater compressive stiffness than the other adjacent pair of rubber pads or blocks. Also, as previously described herein for the mounting of Fig. 3, the pads of lesser compressive stiffness are, in the unassembled unit, of greater thickness than the pads of greater compressive stiffness, the pads of lesser compressive stiffness being precompressed to a greater extent than the pads of greater compressive stiffness on assembly of the unit so that the unit will be horizontal on its support.

WHAT WE CLAIM IS:—

1. A mounting unit of the type described wherein at least two of the rubber pads are

constructed to exhibit compressive stiffnesses one selectively greater than the other and the arrangement of the pads is such as to impart to the unit a direction of maximum stiffness inclined to said static loading axis.

2. A mounting unit according to Claim 1, wherein there are four pairs of confronting surfaces following the form of a square pyramid and the compressive stiffness of an adjacent pair of the four rubber pads between each surface is selectively greater than that of the other pair of pads.

3. A mounting unit according to Claim 1 or 2, wherein the pad or pads of greater compressive stiffness are stiffer by virtue of at least one metal interleaf incorporated in each.

4. A mounting unit as claimed in any preceding claim, wherein in the unloaded state the pad or pads of lesser compressive stiffness is or are thicker than the pad or pads of greater compressive stiffness, whereby the support member is supported horizontally from the base by the pads when the mounting is under a predetermined load.

5. A mounting unit as claimed in Claim 4, wherein said load is a precompression load.

6. An installation comprising a body supported on mounting units according to any one of the preceding claims, wherein there are at least three of the units arranged in a horizontal plane and providing an effective point of suspension for the body.

7. An installation according to Claim 6, wherein the effective point of suspension of the body is disposed above the horizontal plane of the mounting units and below the centre of gravity of the body.

8. A mounting unit constructed and arranged substantially as hereinbefore described with reference to and as shown in Fig. 3 or 5 of the accompanying drawings.

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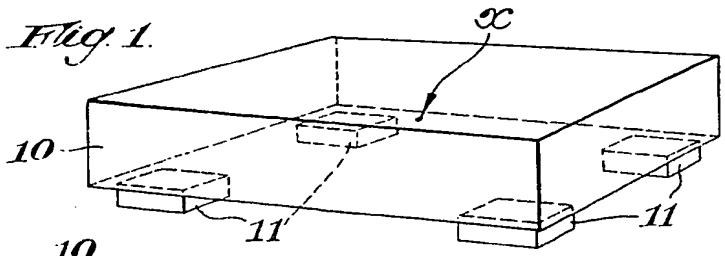
932,086 COMPLETE SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

Fig. 1.



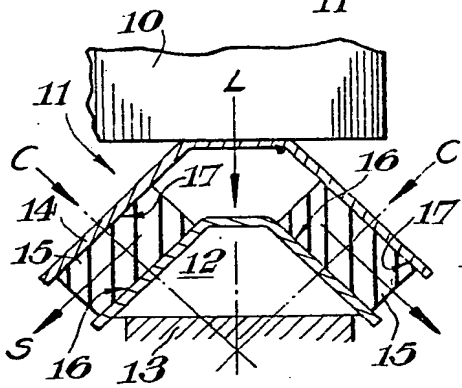


Fig. 2.

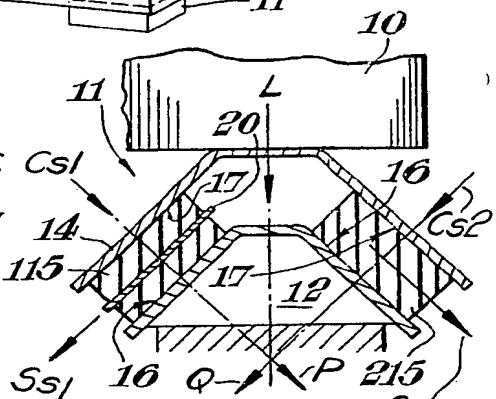


Fig. 3.

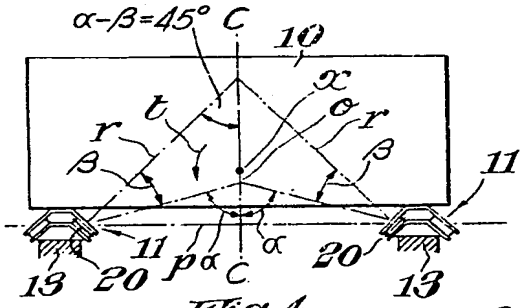


Fig. 4.

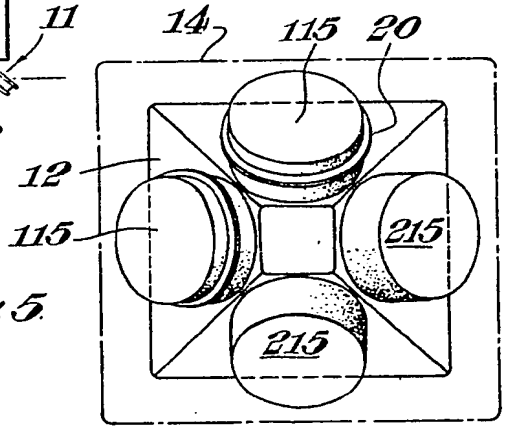


Fig. 5.

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